

Vulnerability of Coastal Wetlands in the Southeastern United States: Climate Change Research Results, 1992-97

Biological Science Report
USGS/BRD/BSR—1998-0002

Department of the Interior
Geological Survey

 **USGS**
science for a changing world

QH
540
.U64
no.
1998-02

Technical Report Series

The Biological Resources Division publishes scientific and technical articles and reports resulting from the research performed by our scientists and partners. These articles appear in professional journals around the world. Reports are published in two report series: Biological Science Reports and Information and Technology Reports.

Series Descriptions

Biological Science Reports

ISSN 1081-292X

This series records the significant findings resulting from sponsored and co-sponsored research programs. They may include extensive data or theoretical analyses. Papers in this series are held to the same peer-review and high quality standards as their journal counterparts.

Information and Technology Reports ISSN 1081-2911

These reports are intended for publication of book-length monographs; synthesis documents; compilations of conference and workshop papers; important planning and reference materials such as strategic plans, standard operating procedures, protocols, handbooks, and manuals; and data compilations such as tables and bibliographies. Papers in this series are held to the same peer-review and high quality standards as their journal counterparts.

Cover photo: Don Cahoon, USGS

Copies of this publication are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161 (1-800-553-6847 or 703-487-4650). Copies also are available to registered users from the Defense Technical Information Center, Attn.: Help Desk, 8725 Kingman Road, Suite 0944, Fort Belvoir, Virginia 22060-6218 (1-800-225-3842 or 703-767-9050).



Printed on recycled paper

Vulnerability of Coastal Wetlands in the Southeastern United States: Climate Change Research Results, 1992-97

Biological Science Report

USGS/BRD/BSR-1998-0002

September 1998

By

Glenn R. Guntenspergen

Beth A. Vairin

Editors

U.S. G.S. National Wetlands
Research Center Library
700 Cajundome Blvd.
Lafayette, LA 70506

U.S. Department of the Interior
U.S. Geological Survey
National Wetlands Research Center
700 Cajundome Blvd.
Lafayette, LA 70506

Suggested citation:

Guntenspergen, G.R., and B.A. Vairin, editors. 1998. Vulnerability of coastal wetlands in the Southeastern United States: climate change research results, 1992-97. U.S. Geological Survey, Biological Resources Division Biological Science Report USGS/BRD/BSR—1998-0002. 101 pp.

Contents

Abstract	vi
Chapter 1. Overview of Coastal Wetland Global Climate Change Research, <i>Glenn R. Guntenspergen, Beth A. Vairin, and Virginia Burkett</i>	1
Chapter 2. Global Climate Change and Communities of Submersed Vegetation: Research Summary of Selected Environmental Impacts, <i>William M. Rizzo and Hilary A. Neckles</i>	7
Chapter 3. Global Climate Change and Sea-level Rise: Estimating the Potential for Submergence of Coastal Wetlands, <i>Donald R. Cahoon, John W. Day, Jr., Denise J. Reed, and Robert S. Young</i>	19
Chapter 4. Freshwater Forested Wetlands and Global Climate Change, <i>James A. Allen, William H. Conner, Richard A. Goyer, Jim L. Chambers, and Ken W. Krauss</i>	33
Chapter 5. Sensitivity of Gulf Coast Forests to Climate Change, <i>Paul A. Harcombe, Rosine B.W. Hall, Jeff S. Glitzenstein, Edward S. Cook, Paul Krusic, Mark Fulton, and Donna R. Streng</i>	45
Chapter 6. Modeling Global Change Effects on Coastal Forests, <i>Thomas W. Doyle</i>	67
Chapter 7. Identifying Wetland Zonation and Inundation Extent by Using Satellite Remote Sensing and Ground-based Measurements, <i>Elijah W. Ramsey III, Stephen C. Laine, Gene A. Nelson, Sijan K. Sapkota, Marshall L. Strong, Jennifer K. Wooderson, Richard H. Day, Ruth E. Spell, Dal K. Chappell, Troy L. Stoute, Robert G. Kirkman, and Mark A. Books</i>	81
Literature Cited	91

Figures

Number	Page
2-1	8
2-2	10
2-3	11
2-4	12
2-5	12
2-6	13
2-7	13
2-8	13
2-9	14
2-10	17
3-1	21
3-2	21
3-3	22
3-4	25
3-5	26
3-6	26
3-7	27
3-8	28
3-9	29
3-10	31
3-11	31
4-1	34
4-2	36
4-3	38
4-4	38
4-5	39
4-6	40
4-7	41
4-8	42
4-9	42
4-10	43
4-11	43
5-1	48
5-2	49
5-3	52
5-4	56
5-5	57
5-6	57
5-7	58

5-8	Box plots of median dbh growth of large saplings by species at a wet site.	59
5-9	Tree-ring site locations in the Big Thicket region.	59
5-10	Surface maps of precipitation and maximum temperature over the Big Thicket region.	60
5-11	Varimax rotated factor loadings for each phylogenetic group on each principal components analysis factor.	62
5-12	Varimax factor loadings for each of the four phylogenetic groups.	64
5-13	Varimax loadings by longitude for pine chronologies.	65
6-1	Mangrove forest damage assessment of coastal transect in south Florida.	69
6-2	Proportion of severely damaged stems by species and crown class for sites within the eyepath and outside the radius of maximum winds.	70
6-3	Scatter diagram and regression of actual mean treefall azimuths by site and predicted wind angle at peak hurricane wind speeds from the HURASIM simulation for all sample sites.	70
6-4	Scatter diagram and curvilinear fit of percent light penetrating the residual forest canopy and maximum predicted wind speed from the HURASIM simulation for all sample sites.	71
6-5	Damage probability curves calibrated from field observations.	72
6-6	Frequency of hurricane strikes of Category 2 storms or greater by quadrangle across south Florida predicted by HURASIM model for mangrove habitat for 1886-1989.	73
6-7	Mean stand diameter for a composite sampling of all 41 stand simulations of mangrove habitat for each decade under no-hurricane, low, moderate, and high impact scenarios for the period of hurricane history 1886-1989.	74
6-8	Habitat map of Big Bend coastal region including the area of St. Marks National Wildlife Refuge south of Tallahassee, Florida.	74
6-9	Digital elevation model for Big Bend coastal region encompassing St. Marks National Wildlife Refuge south of Tallahassee, Florida.	76
6-10	Sea-level rise projections and equations for case scenarios of low, moderate, and high cases based on Intergovernmental Panel on Climate Change 1995.	77
6-11	Predicted shoreline change and coastal inundation at 15-, 50-, and 95-cm estimates of sea-level rise by the year 2100 based on IPCC (1995) projections	77
6-12	Predicted changes of net loss and/or gain of coarse habitat types, open water, emergent marsh, and forest	77
7-1	Landsat Thematic Mapper band 5 (mid-infrared) image of the study site at the St. Marks National Wildlife Refuge (NWR) in the Big Bend area of Florida.	83
7-2	ERS-1 SAR images collected on October 18 (nonflooded) and September 13 (flooded) of 1993 of a black needlerush marsh within the St. Marks NWR.	84
7-3	The modeled topographic surface map with one transect location.	84
7-4	Comparison of different data sources.	86
7-5	Classified map generated from a combination of the three data sources.	87
7-6	Monitoring the recovery of a burned marsh.	87
7-7	Scatter plots of number of days since burn versus signal return from different burned-marsh study sites.	88
7-8	Comparison of actual water level and salinity data with the data obtained as an output of the flushing model.	89

Tables

<i>Number</i>		<i>Page</i>
2-1	Potential changes in community composition of various species of submerged aquatic vegetation.	16
3-1	Accretion, elevation, and shallow subsidence rates for selected coastal marshes in the United States.	24
4-1	Flood and salinity tolerance rankings for tree species in forested wetlands.	37
4-2	Potential Survival Index by tree family.	39
4-3	Annual dieback of understory baldcypress saplings in southern Louisiana 1992-97.	42
5-1	Basal area and annualized percent change in basal area for three study sites in gulf coast forests.	47
5-2	Changes over time in relative densities of greater than 1-year-old woody seedlings in 100 1 m by 1 m plots at a dry study site	53
5-3	Light gradient position of Neches Bottom species compared to expected shade tolerance	56
5-4	Species and basic taxonomy of 104 tree-ring chronologies	61
5-5	Relationship of maximum ring growth to longitude (° W) for tree species sampled at greater than five sites	61

Abstract: As part of the USGCRP research framework on coastal lands and ecosystems, the Biological Resources Division of the U.S. Geological Survey (National Wetlands Research Center) entered into partnership with Rice University, Louisiana State University, Duke University, Clemson University, University of Southwestern Louisiana, University of Georgia, and the Virginia Institute of Marine Science (College of William and Mary) to (1) document the current state and vulnerability of coastal ecosystems including an assessment of past changes in land cover, (2) develop an understanding of the processes which underlie these changes, and (3) predict the extent of future alterations to these habitats and the consequences for the sustainability of the resource and land base. This document summarizes the initial findings of our collaborative efforts. Overall, the studies exemplify an integrated approach addressing questions at the species, community, and landscape levels of organization and focusing on factors related to hydroperiod, sea-level rise, disturbance events, and coastal marsh submergence.

Key Words: Climate change, sea-level rise, coastal ecosystems, subsidence, disturbance events, hydroperiod
